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(54) SOLID STATE IMAGE PICKUP DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To give some allowance for voltage setting of a substrate at incorporation into a system by lightening the dependency upon the substrate voltage of the output signal level of a solid state image pickup device.

SOLUTION: A solid state image pickup device equipped with light receiving regions 11 arranged in matrix form and vertical transfer parts 15 consisting of second p-type wells 13 and n-type layers 12 arranged in the horizontal transfer direction of these light receiving regions 11 have a p-type semiconductor layer 13a between the light receiving regions 11 adjoining each other in vertical transfer direction. This p-type semiconductor layer 13a narrows the low-concentration region right under the light receiving region 11, restrains the charge accumulated in the light receiving region 11 from being swept out to the side of the substrate, lessens the change of the output signal level of the solid state image pickup device to the change of the voltage applied to the semiconductor substrate, and gives some allowance for setting of substrate voltage.

CLAIMS

[Claim(s)]

[Claim 1]An opposite conductivity type light-receiving field is arranged on a semiconductor layer of one conductivity type at matrix form, A solid state image pickup device, wherein a semiconductor layer of one conductivity type is formed

in both sides of the direction of vertical transfer of said light-receiving field in a solid state image pickup device with which it comes to allocate a vertical transfer part which transmits an electric charge accumulated in these light-receiving field in the direction of vertical transfer between the directions of horizontal transfer of each of said light-receiving field.

[Claim 2]A solid state image pickup device of claim 1 characterized by comprising the following.

The 1st 1 conductivity-type well formed on an opposite conductivity type semiconductor substrate.

An opposite conductivity type light-receiving field arranged on a well of said 1st one conductivity type at matrix form.

The 2nd 1 conductivity-type well formed so that it might extend in the direction of vertical transfer of an electric charge on said 1st 1 conductivity-type well.

One conductivity type semiconductor layer formed between an opposite conductivity type layer which is formed so that it may extend in the direction of vertical transfer on said 2nd 1 conductivity-type well, and constitutes a vertical transfer part from said 2nd 1 conductivity-type well, and said light-receiving field which is formed on said 1st 1 conductivity-type well, and adjoins in the direction of vertical transfer.

[Claim 3]A solid state image pickup device of claim 1 or 2 which comes to spread a semiconductor layer of said one conductivity type to a part of light-receiving field [directly under].

[Claim 4]A solid state image pickup device of claim 2 or 3 with which it comes to dissociate said 2nd 1 conductivity-type well that forms said vertical transfer part, and said one conductivity type semiconductor layer which adjoins in the direction of vertical transfer of said light-receiving field.

[Claim 5]One solid state image pickup device of claims 2 thru/or 4 with which it comes to extend the 2nd 1 conductivity-type well even directly under [part] said light-receiving field in the direction of horizontal transfer.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]Especially this invention relates to the structure about a solid state image pickup device.

[0002]

[Description of the Prior Art]The CCD (Charge Coupled Device) mold solid state image pickup device in recent years has mainly adopted vertical mold overflow drain (it is hereafter described as VOD) structure. Since this VOD structure is the structure which sweeps out the excessive charges by which it was generated in the light-receiving field to a substrate internal direction, it is not necessary to sweep it out to the plane direction of an element, it does not need to form the drain of business and can stop the size of an element, its structure of a solid state image pickup device is in use. Drawing 5 is a flat-surface layout pattern of the solid state image pickup device of the conventional VOD structure, and a sectional view of a light-receiving area part where drawing 6 meets the BB line. The 1st P type well 17 is formed on the semiconductor substrate 16 of N type,

and the light-receiving field 11 of N type is formed in the principal surface. The vertical transfer part 15 which consists of the N type layer 12 formed the 2nd high-concentration P type well 13 and on it rather than the 1st P type well 17 as adjoined this light-receiving field 11 is formed, The electric charge generated in the light-receiving field 11 is read to the vertical transfer part 15 through the charge read section 14 of N type.

[0003]Here, although the electric charge generated in the light-receiving field 11 is accumulated in a light-receiving field with optical irradiation time, if the amount of stored charge exceeds the charge storage capacity of a light-receiving field, the excessive charges will leak to the adjoining vertical transfer part 15 and the light-receiving field 11, and a blooming phenomenon will generate them. In order to control this, excessive charges are swept out to the N type board 16 side by impressing positive voltage to the N-type semiconductor board 16, and lowering the potential barrier of the 1st P type well 17. If impressed electromotive force to the N-type semiconductor board 16 is made high, the charge storage capacity of the light-receiving field 11 will decrease, and the charge storage capacity of a light-receiving field will be set to 0 with a certain substrate voltage. Drawing 7 shows the dependence characteristic to the substrate voltage of the amount of charge storages of the light-receiving field 11. The voltage impressed to the N-type semiconductor board 16 in order to sweep out excessive charges

changes with the concentration of the P type impurity of the P type well [directly under] 17 of the light-receiving field 11. Since the potential barrier by the P type well 17 will become large if P type impurity concentration becomes high, in order to lower the barrier, the voltage impressed to the N-type semiconductor board 16 becomes high. Therefore, since the degree of P type ******** directly under a light-receiving field will become high uniformly, and the potential barrier of the P type well 17 will become high as drawing 8 shows if the degree of ******** of the 1st P type well is made high, The electric charge accumulated in the light-receiving field 11 becomes is hard to be swept out at the substrate side uniformly, and the substrate voltage dependence characteristic of the amount of charge storages of a light-receiving field is uniformly shifted in the direction with high substrate voltage.

[0004]On the other hand, in order that the 2nd P type well 13 may prevent the phenomenon which leaks to the vertical transfer part 15 without accumulating the electric charge which carried out photoelectric conversion and was generated in the depths of the light-receiving field 11 in the light-receiving field 11, and what is called a smear, Are formed directly under the vertical transfer part 15 so that the P type impurity concentration [directly under] of the vertical transfer part 15 may become higher than the 1st P type well 17, but. By heat treatment after the ion implantation process, actually, from the pattern of a mask,

a P type impurity is spread toward directly under [of the light-receiving field 11] from the direction both sides of horizontal transfer of the light-receiving field 11, the degree of P type ******** has a low center directly under a light-receiving field, and horizontal both ends become high effectually. Therefore, the substrate voltage dependence characteristic of the charge storage capacity of the light-receiving field 11 will also be influenced according to the diffusion state of the impurity of the 2nd P type well 13.

[0005]

[Problem(s) to be Solved by the Invention]When such a conventional solid state image pickup device especially is used for powerful cameras, such as business use, in order to secure the characteristics, such as sensitivity, more than a certain amount of size needs to secure the size of 1 pixel, and the picture element pitch of the direction of horizontal transfer also becomes large by expansion of a light-receiving field in that case. On the other hand, if the picture element pitch of the direction of horizontal transfer of a solid state image pickup device becomes large, the area of the field 17a where the degree of P type ******** of the center [directly under] of the light-receiving field 11 is low will become large. Since the low field of the potential barrier of the P type well of the light-receiving field 11 becomes large so that the area of this field 17a is large, the charge quantity accumulated in the light-receiving field 11 becomes is easy

to be swept out to the substrate 16 side, and the variation of the amount of stored charge of the light-receiving field to carry out to substrate voltage becomes large. When the variation of stored charge to this substrate voltage is too large, and this solid state image pickup device is built into the set of a camera etc., the setting range of substrate voltage becomes narrow and there is a problem that a margin is lost. A margin will be lost also to change of the substrate voltage by change of the power supply voltage of a set, etc.

[0006]Although the method which make stored charge hard to make high impurity concentration of the 1st P type well 17, and to sweep out to the substrate side here is also considered, Since the potential barrier of the field 17a where the degree of P type ******** of the center of the light-receiving field 11 is low becomes high simultaneously with a light-receiving field periphery as mentioned above, uniformly the substrate voltage characteristic of the amount of stored charge only, and the variation of an output signal to substrate voltage does not become small. [method side of high tension]

[0007]The purpose of this invention eases the substrate voltage dependency of an output signal level, and there is in providing the solid state image pickup device which made it possible to enlarge the margin of the substrate voltage at the time of system inclusion.

[0008]

[Means for Solving the Problem]A light-receiving field of an opposite conductivity type [this invention / top / of one conductivity type / semiconductor layer] is arranged at matrix form, A semiconductor layer of one conductivity type is formed in both sides of the direction of vertical transfer of said light-receiving field in a solid state image pickup device with which it comes to allocate a vertical transfer part which transmits an electric charge accumulated in these light-receiving field in the direction of vertical transfer between the directions of horizontal transfer of each of said light-receiving field. For example, the 1st 1 conductivity-type well formed on an opposite conductivity type semiconductor substrate, An opposite conductivity type light-receiving field arranged on a well of said 1st one conductivity type at matrix form, The 2nd 1 conductivity-type well formed so that it might extend in the direction of vertical transfer of an electric charge on said 1st 1 conductivity-type well, An opposite conductivity type layer which is formed so that it may extend in the direction of vertical transfer on said 2nd 1 conductivity-type well, and constitutes a vertical transfer part from said 2nd 1 conductivity-type well, It has composition provided with one conductivity type semiconductor layer formed between said light-receiving fields which are formed on said 1st 1 conductivity-type well, and adjoin in the direction of vertical transfer.

[0009]Here, a semiconductor layer of said one conductivity type is considered as

composition diffused to a part of light-receiving field [directly under]. It is preferred that said 2nd 1 conductivity-type well that forms a vertical transfer part, and said one conductivity type semiconductor layer which adjoins in the direction of vertical transfer of said light-receiving field are separated.

[0010]

[Embodiment of the Invention]Next, the embodiment of this invention is described with reference to drawings. Drawing 1 is a top view of the solid state image pickup device of one example of this invention, and is a figure showing the light-receiving field 11, the charge read section 14, and the vertical transfer part 15. The vertical transfer part 15 which adjoins in the direction of horizontal transfer and consists of the N type well 12 and the 2nd P type well 13 is formed to each vertical transfer sequence of the light-receiving field 11 arranged at matrix form, Also directly under the isolation region between the light-receiving fields 11 which adjoined in the direction of vertical transfer, every which is formed where said a part of 2nd P type well 13 is extended, and constitutes each vertical transfer part 15 of the both sides of the direction of horizontal transfer of the light-receiving field 11 by this 2nd P type well 13a -- the 2nd P type -- it is provided so that the well 13 may be connected, respectively.

[0011]Drawing 2 is a sectional view which meets in the AA line of vertical transfer, i.e., direction, of drawing 1. The sectional view which meets in the

direction of horizontal transfer is almost the same as composition conventionally which was shown in drawing 6. Drawing 2 shows the composition which the 1st P type well 17 was formed on the N-type semiconductor board 16, and said light-receiving field 11 was formed in that principal surface, and formed a part of 2nd P type well 13 13a so that it might face across this light-receiving field 11 in the direction of vertical transfer. The 2nd P type well 13a provided in the both sides of the direction of vertical transfer of the light-receiving field 11 as described above is spreading from a actual mask pattern up to light-receiving field 11 lower one by ******. The degree of P type ******** of the both ends of the direction of vertical transfer of the light-receiving field 11 becomes high by this, and the area of the portion 17a with low P type impurity concentration of the center of a light-receiving field becomes narrow. Therefore, it becomes difficult to sweep out the electric charge accumulated in the light-receiving field 11 to the N-type semiconductor board 16 side.

[0012]The dashed line of drawing 3 shows the dependency to the substrate voltage of the stored charge of a light-receiving field when the P type well 13a is formed between the light-receiving fields 11 which adjoined in the direction of vertical transfer. Variation deltaVo1 of the stored charge of a light-receiving field when a P type well is provided between light-receiving fields becomes smaller than variation **Vo2 of stored charge in case there is no P type well of the figure

solid line to variation deltaVsub of the same substrate voltage. Therefore, since change of an output signal becomes small even if gap of some arises in the preset value of substrate voltage when it includes in the set of a camera etc., a leeway is given in the substrate voltage range, and a leeway is given also to change of the substrate voltage by change of the power supply voltage of a set, etc.

[0013]Drawing 4 is a top view of the solid state image pickup device of a 2nd embodiment of this invention. As a 1st embodiment explained, become a barrier to the electric charge which photoelectric conversion occurs in the depths of the light-receiving field 11, and flows into the vertical transfer part 15 directly, and there is an effect which controls a smear in the 2nd P type well 13 provided under the vertical transfer part 15, but. If the pattern of the 2nd P type well 13 projects to the light-receiving field 11 not much, in order for an electric charge to occur between the beetle P type well 13 and the light-receiving field 11 and to leak to the vertical transfer part 15, the effect of smear control becomes low. If the P type well 13a is formed as it is almost hard-pressed in distance between the pixels which adjoined in the direction of vertical transfer and being described above here, If it comes to jut out of the restriction on a process toward the light-receiving field 11 and this P type well 13a is connected with the 2nd P type well 13 of the vertical transfer part 15, the electric charge of a smear component

will leak to the vertical transfer part 15 through this P type well 13a, and the smear characteristic will be degraded.

[0014]So, in this 2nd embodiment, the pattern of the 2nd P type well 13 of the vertical transfer part 15 and the pattern of the 2nd P type well 13a provided between the light-receiving fields 11 which adjoined in the direction of vertical transfer are separated. Since the P type impurity concentration between the portion between the light-receiving fields 11 and the vertical transfer part 15 will become low even if the 2nd P type well 13a provided between the light-receiving fields 11 projects over the light-receiving field 11 if it does in this way, The electric charge of a smear component leaks to the vertical transfer part 15, it becomes difficult to be crowded, and degradation of the smear characteristic can be prevented.

[0015]

[Effect of the Invention]As explained above, this invention between the light-receiving fields which adjoin in the direction of vertical transfer of an electric charge, By providing the semiconductor layer of the same conductivity type as the 1 conductivity-type well which constitutes a vertical transfer part, It controls that the electric charge accumulated in the light-receiving field is swept out to the substrate side even when the size of 1 pixel is secured as for more than a certain amount of size, Since change of the output signal level of the solid state image

pickup device to the change of potential impressed to a semiconductor substrate can be made small, a margin can be given to setting out of substrate voltage when building this solid state image pickup device into the set of a camera etc. A leak lump of the electric charge of the smear component to the vertical transfer part which lets one conductivity type semiconductor layer between light-receiving fields pass can be prevented by separating one conductivity type semiconductor layer provided between the light-receiving fields which adjoin in the 1 conductivity-type well and the direction of vertical transfer of a vertical transfer part.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a top view of a 1st embodiment of the solid state image pickup device of this invention.

[Drawing 2]It is a sectional view which meets AA line of drawing 1.

[Drawing 3]It is a figure showing the substrate voltage dependency of the amount of charge storages of a light-receiving field.

[Drawing 4]It is a top view of a 2nd embodiment of the solid state image pickup device of this invention.

[Drawing 5]It is a top view of an example of the conventional solid state image pickup device.

[Drawing 6]It is a sectional view which meets BB line of drawing 5.

[Drawing 7]It is a figure showing the substrate voltage dependency of the amount of charge storages of a light-receiving field.

[Drawing 8]It is a potential figure of the direction of vertical transfer of a VOD structure solid state image pickup device.

[Description of Notations]

11 Light-receiving field

12 The 1st N type layer

13 The 2nd P type well

13a The 2nd P type well arranged in the direction of vertical transfer

14 Charge read section

15 Vertical transfer part

16 N-type semiconductor board

17 The 1st P type well